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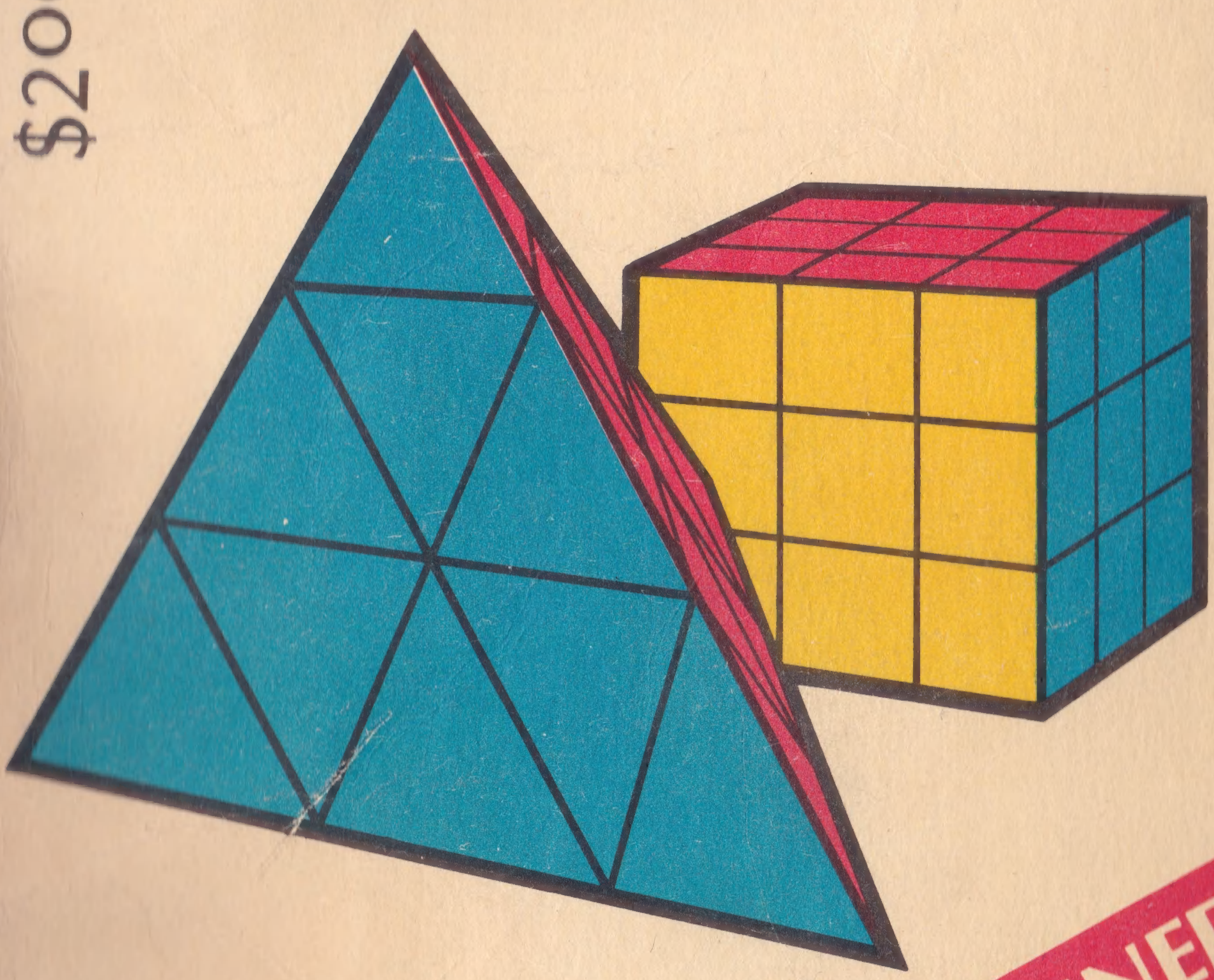

THE CANADIAN SOLUTION

TWO BOOKS COMBINED!

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by Frank Lenard

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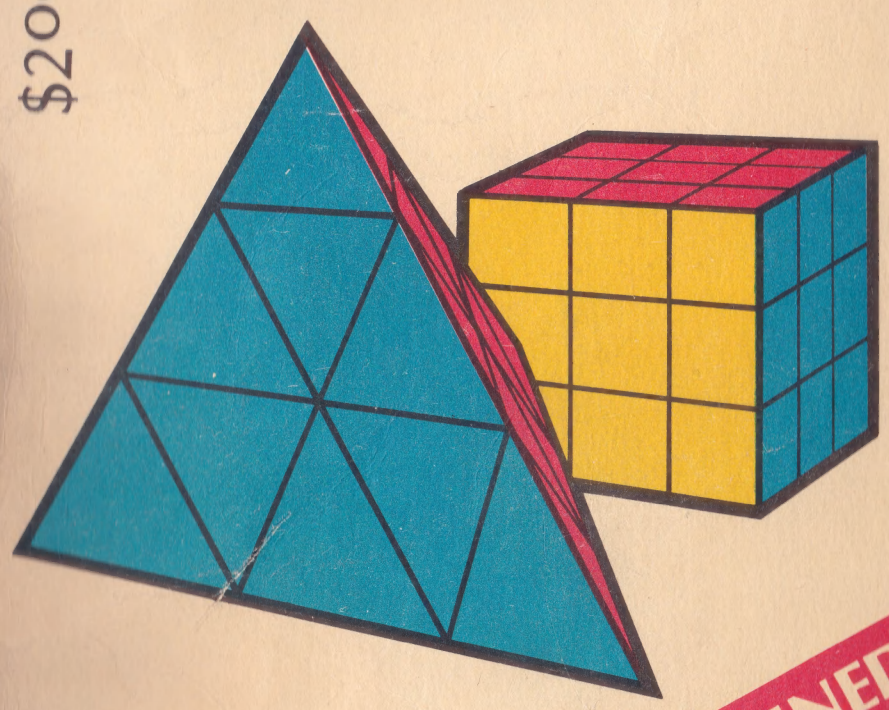

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D.T.D.

CONTENTS

RUBIK'S CUBE

FOREWORD	1
ABOUT THE AUTHOR	1
ACKNOWLEDGEMENTS	1
GETTING TO KNOW YOUR CUBE	2
SYMBOLS AND NAMES	3
FIRST FOUR EDGES	3
FIRST FOUR CORNERS	4
TOP CORNERS	4
TO FLIP CORNERS	6
TWO CORNER FLIP	6
FOUR CORNER FLIP	7
THREE CORNER CLOCKWISE FLIP	7
THREE CORNER COUNTER CLOCKWISE FLIP	8
TOP EDGES	8
MIDDLE BELT EDGES	11
EDGE FLIPS	12
PRETTY PATTERNS	13
KRAZY SHAPES	14

PYRAMID™ PUZZLE

FOREWORD	16
GETTING TO KNOW YOUR PYRAMID	16
HOW DOES IT WORK	17
TO RESTORE YOUR PYRAMID	18
FIXING THE ROOF	20
ROTATE ROOFS AROUND TOP BASE	21
MOVING ROOFS ON RIGHT FACE	22
EXCHANGE TWO PAIRS OF ROOFS	23
FLIP TWO ROOFS	24
THE MISSING LINK	25
THE SNAKE	26

FOLD OUT FLAP TO FOLLOW YOUR PROGRESS.

FOREWORD

When I was demonstrating the cube at a large department store, I heard the remark time and time again:

"But isn't it cheating to restore the cube by using a book?"

Well, when the lady of the house bakes a cake (or a pie) from "scratch" is she using a recipe she invented herself?

Most likely not.

Does she call this cheating? No! Indeed, she is rather proud of herself.

ABOUT THE AUTHOR, FRANK LENARD

Frank is an assembly line worker at the Ford Motor Co., St.Thomas Assembly Plant (UAW member for 25 years) building Escort, Lynx, EXP and LN7 models.

Because of his job, Frank is uniquely qualified to solve these formidable puzzles.

ACKNOWLEDGMENTS

I am greatly indebted to Mr. Vern Leffler, Teacher of Mathematics and Computer Sciences at Lauriel Secondary School, London, Canada, for his kind encouragement and useful suggestions.

GETTING TO KNOW YOUR CUBE

There are six sides (faces) on the cube. Each face has a center piece on it. They always stay put in relation with all other center pieces.

When you turn a face, the center piece on it is not going anywhere. It just rotates in its own place.

This makes the cube very simple. We know we can rely on the center piece.

The colour of the center piece determines the colour of the face.

The Corners: There are eight of them, and they can move all over the cube.

But they mingle only with their own kind. Only corner pieces will fit into corner places.

This makes the cube even simpler.

The Edges: There are one dozen of them. They also move all over the cube. But as with the corners, they keep to themselves. Only edge pieces can get into edge places.

Each individual edge piece and each individual corner piece has a home of its own. They can go visiting but you can tell at a glance whether they are at home or not, because of the colours on them.

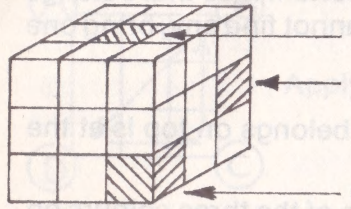
This makes the cube so simple we just have to say:

There is no magic to this magic cube!

So we have:

6 centers with 1 colour each
8 corners with 3 colours each
12 edges with 2 colours each

SYMBOLS AND NAMES



L=LEFT **R**=RIGHT **F**=FRONT **B**=BACK

U=TOP (UP) **D**=BOTTOM (DOWN)

OPERATOR means a sequence of turns (rotations) designed to achieve a specific objective.

CLOCKWISE = a turn of a face in the same direction the hands on your clock move.

COUNTER CLOCKWISE = a turn of a face in the opposite direction of clockwise.

When we want you to perform one turn or sequence of turns we will always use the word **"APPLY"** Thus:

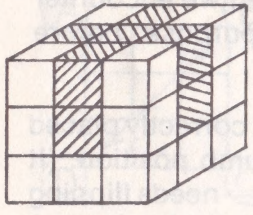
APPLY U means one 90° clockwise turn of the top face.

APPLY U^{-1} means one 90° counter clockwise turn of the top face.

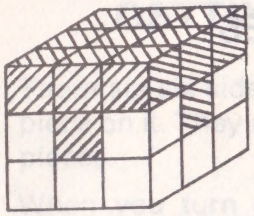
APPLY U^2 means one 180° turn of the top face.

STAGE ONE **FIRST FOUR EDGES**

To make explanation easier in some later chapters, let's agree to use white for the bottom face.



O.K. Hold the cube so white center piece is resting on your palm. One by one locate edges that belong on top and place them on top face. (Make sure to match up sides of edges with center pieces on all four sides.)



FIRST FOUR CORNERS

Locate a corner on bottom face that belongs in top face. (If you cannot find any, bring one down from top.)

Now rotate bottom face till corner that belongs on top is at the bottom-front-right position.

Colour of top center piece matches one of the three colours on the corner piece.

Matching colour could be on the front or left or bottom side of the corner piece.

If on —

Front — apply FDF^{-1}

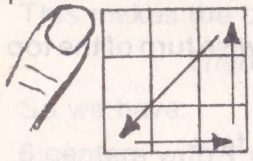
Right — apply $R^{-1}D^{-1}R$

Bottom — apply $R^{-1}DRFD^{2}F^{-1}$

Now that we got our first face in, tip cube upside down. From now on, white is our top face.

STAGE TWO TOP CORNERS

The operator below will put all top corners into their proper place.



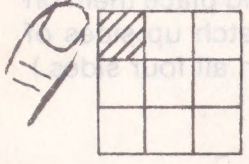
OPERATOR # 1

$U^{-1}LUL^{-1}U^{-1}B^{-1}U^{-1}B$

Three corners will change places in the direction the arrows indicate.

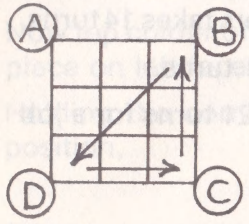
There are five possible ways we may encounter the corners and Operator # 1 rotates them in one, pre-set way.

So whatever way the corners are situated, when we encounter them, we will have to set them up "to suit our purpose" before applying Operator # 1.

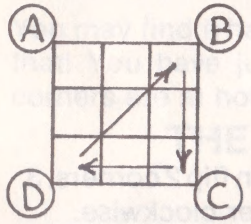


First, rotate top till we have a correctly placed corner piece in the left thumb position. (It may be incorrectly oriented — needs flipping — but that is O.K. at this stage.)

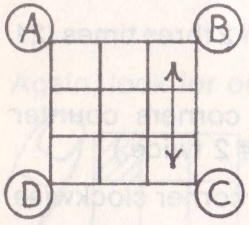
Now check which way the rest of the corners need to be moved.



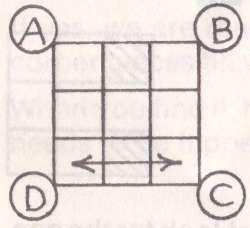
Apply Operator # 1.



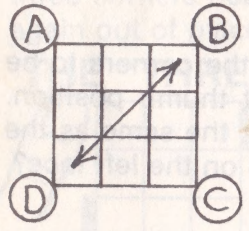
Apply U^{2} then hold cube so B corner is in the left thumb position and apply Operator #1.



Apply U then hold cube so C corner is in the left thumb position and apply Operator # 1.



Apply U then hold cube so D corner is in the left thumb position and apply Operator #1.



We have to apply our operator twice for this situation:

Apply Operator # 1. Now apply U then hold cube so C corner is in the left thumb position and apply Operator # 1 again.

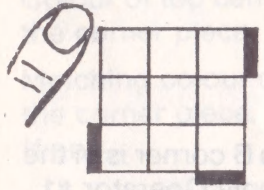
STAGE THREE TO FLIP CORNERS

The most widely used operator to flip two corners takes 14 turns.

My corner flipper, in many instances takes 21 turns.

At first glance, it seems unreasonable to use 21 turns for a job that someone else is using only 14 for.

But let's see how it works:



OPERATOR # 2

$FUF^{-1}UFU^2F^{-1}$

Operator # 2 is a universal corner flipper. We can flip 2 corners, 3 corners, 4 corners with it, clockwise or counter clockwise.

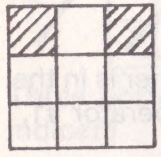
The big advantage of it is obvious: we have to memorize only 7 turns, all of them on only two faces.

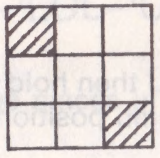
To flip any 2 corners, we have to use Operator # 2 three times (21 turns).

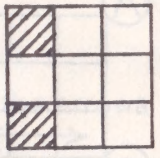
But to flip 4 corners either way, or three corners counter clockwise will take only 14 turns. (Operator # 2 twice.)

It gets even better when we are faced with a 3 corner clockwise flip: apply Operator # 2 once (7 turns).

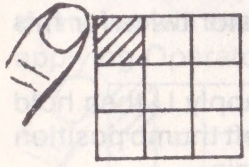
THE "TWO CORNER" FLIP







No matter which two corners need flipping, just look for the one that needs to be flipped clockwise.



Hold the cube so one of the corners to be flipped will be in the left thumb position. Check its top colour. Is it the same as the colour of the center piece on the left face?

If yes, we are in business. If not, repeat above with the other corner to be flipped.

Now top colour of corner to be flipped matches colour of center piece on left face. (This **is** the corner to be flipped clockwise.)

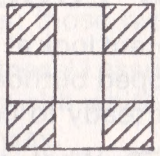
Holding the corner to be flipped clockwise in the left thumb position,

APPLY OPERATOR # 2

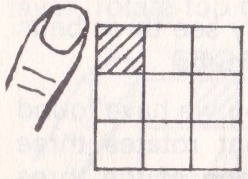
Now you should have all four corners in the wrong place and all 4 need flipping too.

You may find it hard to believe me, but this is progress! (I heard that! You have just called me a *politician.*) Apply U^2. All 4 corners are at home now.

THE "FOUR CORNER" FLIP



Again, look for one corner that needs to be flipped clockwise.



Hold the cube so one of the corners that needs flipping will be in the left thumb position. Check its top colour. It it the same as the colour of the center piece on the left face?

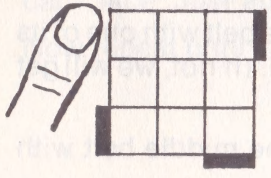
If yes, we are ready to roll. If not, repeat above with the other corner pieces till we find one that needs to be flipped clockwise.

When you find it, hold the cube in such a way that the corner that needs to be flipped clockwise is in the left thumb position, and

APPLY OPERATOR # 2

This time it is easy to see progress. We got it down to where only three corners need flipping clockwise. (The corners are once again out of place, but this time just ignore them.)

THE "THREE CORNER CLOCKWISE" FLIP



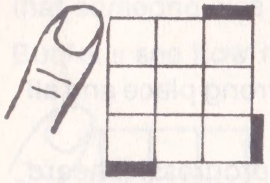
Now hold the cube in such a way that the corner that needs NO flipping is at the left thumb position.

Apply Operator # 2.

All four corners are now correctly placed and correctly oriented.

All we need to know now is how to deal with a three corner counter clockwise flip.

THE "THREE CORNER COUNTER CLOCKWISE" FLIP



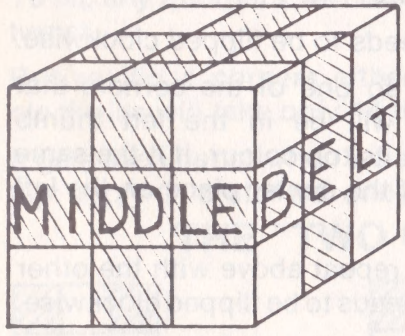
Hold cube so corner that needs no flipping is in the left thumb position.

APPLY OPERATOR # 2

We are faced now with a three corner clockwise flip. (Disregard the fact that corners are once again incorrectly positioned) and follow instructions for the three corner clockwise flip.

STAGE FOUR TOP EDGES

We are going to take a different look at the cube. For the moment think of it as a nicely wrapped birthday present you are giving someone and you are just ready to tie the ribbon on it.



What way does the ribbon go on? Of course!

You can actually see three belts encircling your cube.

Now if I told you we have found an operator that rotates three edges in any one of the three belts without disturbing anything else, would you not say we can work wonders with such an operator?

Well, we sure have found that operator, and we sure are going to work wonders with it.

So what colour is our top layer going to be?

We have agreed earlier to make the top layer white so we may simplify the explanation.

O.K. Can you find an edge piece in the middle belt with one of its two colours being white? Most likely you will. (If not, we will get to that later.)

So your top colour is white. Any edge in the middle belt with

white on it surely must move up to the top. We will give it a little boost!

Hold your cube in your hand, bottom face resting on your palm. Without rotating any of the faces, turn the whole cube in your hand (bottom face still on palm) until edge in the middle belt with white on it is on the back face.

It could be either on back-left or back-right.

Depending on where it is,

B or B^{-1}

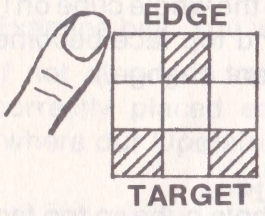
should move it to the top.

But don't do it yet!

First, check the other colour on it. Got it? Now look at the four sides of the top layer. There must be two corners with the same colour on them. That is where our middle belt edge needs to go! Our target is right between those two corners!

Now let's get down to business! I assume the bottom face is still on palm, middle belt edge with white on it is still on back side. Make sure they stay that way.

Now, if our target corners are not already at the front of the top layer, rotate top till both corners are facing you.



NOW APPLY B OR B^{-1}

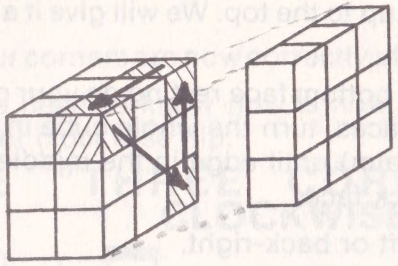
to bring the edge up to the top from the middle belt and we are ready to shoot!

APPLY $LR^{-1}U^2L^{-1}R$ AND EITHER B OR B^{-1}

depending on what preceded our operator.

(You won't have to remember it. You will automatically notice your bottom face colour on either the left or the right side of the back face. Just apply B or B^{-1} like we said before.)

Now repeat until middle belt has nothing that belongs in the top.



Here we have sliced off the right side of our cube so we can observe the effect of Operator # 3 on the edges.

OPERATOR # 3

$LR^{-1}U^2L^{-1}RB^2$

Observe how this operator moves three edges in the same belt but it leaves the bottom front edge intact! (It leaves everything else undisturbed too.)

Very important to remember:

BOTTOM FRONT EDGE STAYS PUT!

If two or four of the top edges are placed incorrectly and none are found in the middle belt, then we start by moving one of the incorrectly placed edges down to the middle belt.

We will accomplish this by using Operator # 3.

Locate edge we want to move. Hold cube with bottom face on your palm and edge to be moved in the top-left position. Now, without any actual rotation of any face, tip the whole cube on its side so bottom face becomes left face and top face becomes right face. (Front-face and back-face do not change.)

APPLY U^{-1}.

Our edge is now in the back-top position.

Again without rotating any face, tip the whole cube so top face becomes front face.

(This time, left-face and right-face do not change.)

APPLY $LR^{-1}U^2L^{-1}RB^2$

APPLY F

Proceed as before to bring top edge up from middle belt to between our target corners.

Once you can do these procedures with confidence and without hesitation, and recognize the reason for holding the cube in so many different ways, then you will be ready for a little refinement.

When moving an edge up from the middle belt to between two corners, make sure it is the colour of the corners and not the colour of the top that is on the back face. (Colour of the tops will be on either the left side or the right side of the back face.)

This will eliminate the need for having to flip them later.

The top face should be all finished now, but you may have one or two edges that need to be flipped.

We will fix them later.

MIDDLE BELT EDGES

We are going to fix the middle belt edges using operator # 3.

Examine belt all around. Can you find one edge that is placed correctly?

Even if it is incorrectly oriented (needs flipping) it is O.K.

But suppose you did not find any.

Hold cube so the bottom face rests on your palm. Without any actual rotation, tip whole cube on its side, so bottom face becomes left face and top face becomes right face. (Front face and back face have not changed.)

APPLY OPERATOR # 3

Examine belt. You will have at least one edge placed correctly.

If not all edges are placed correctly, then hold cube so the correctly placed edge will be in the bottom-front position (where our Operator won't effect it)and

APPLY OPERATOR # 3 AGAIN.

If still not right, apply Operator # 3 again without changing position of the cube.

After a while, when you can do this procedure repeatedly with confidence and without hesitation, you can add a little refinement that will save you a lot of work.

For instance:

Even if you locate an edge that is placed correctly but incorrectly oriented, try to find another edge whose colour matches the colour of the center piece next to it.

Disregard the correctly placed but incorrectly oriented edge and

APPLY OPERATOR # 3.

Now you should have at least one correctly placed and correctly oriented edge.

Another thing to remember is that applying Operator # 3 only once will be sufficient after you have one correctly placed edge.

But you will have to note which way any one of the three incorrectly placed edges needs to move before applying Operator # 3.

If it needs to move towards you, then place correct edge in the bottom-front position and

APPLY OPERATOR # 3

If it needs to move the opposite direction, then turn the whole cube 180° (left becomes right and right becomes left. Top and bottom do not change.)

Now put your correct edge in the bottom-front position and

APPLY OPERATOR # 3

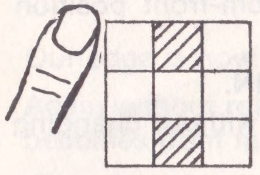
Now the whole cube should be correct but may need a couple of flips.

STAGE FIVE **EDGE FLIPS**

Our edge flipper is very versatile also.

We can flip a pair of edges with it regardless where they may be.

It will flip two edges facing each other.

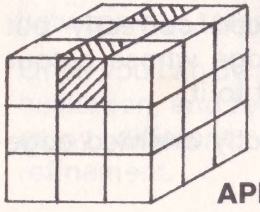


OPERATOR # 4

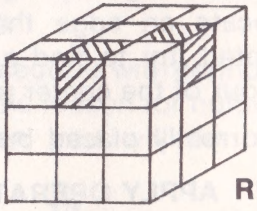
$LR^{-1}FLR^{-1}DLR^{-1}B^2L^{-1}RDL^{-1}RFL^{-1}RU^2$

Here are all possible positions you will find and the "helpers" to bring them in line.

After applying Operator # 4, make sure to undo your helpers in the proper reverse order:

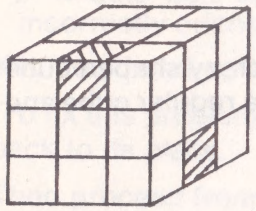


APPLY # 4



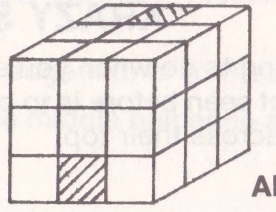
APPLY

$RB + \#4 + B^{-1}R^{-1}$



APPLY

$R^{-1}B + \#4 + B^{-1}R$



APPLY

$F^2 + \#4 + F^2$

PRETTY PATTERNS

With very little experimentation, you can come up with any number of pretty patterns.

The simplest one of them all is the 6-X or Checkerboard. You can do this one blindfolded or behind your back:

$R^2L^2F^2B^2U^2D^2$ or $(RL^{-1}FB^{-1})^3$

Here are two more simple ones:

6-Spot or Dots: $RL^{-1}FB^{-1}UD^{-1}RL^{-1}$

Zig-Zag: RLFB RLFB RLFB

"KRAZY SHAPES"

The first thing to do when you encounter a crazy shaped cube you have not seen before is to put it next to a regular cube and put a ruler across their top.

Same size.

Repeat on the side.

Same size.

Now put it in front of you then stare down on it from the top.

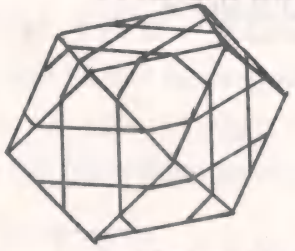
Same shape too. (Except some corners or edges have been trimmed off.)

They may look different at first glance, but they are the same.

So when restoring it, use the same operators you are using for the cube.

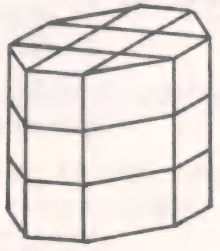
(Make sure you know which ones are your edges and which ones are your corners.)

THE DIAMOND (14 FACES)



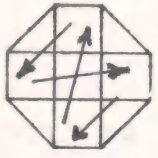
This one looks very impressive, a beautiful rainbow of colours when scrambled up, yet it is the easiest to do because each piece has its own slot, determined by the colours.

THE BARREL (10 FACES)



A very clever innovation.

1. The corners could be correctly oriented but incorrectly placed. This will force top edges to move in unusual ways:



The remedy for this problem is to exchange two opposite columns of corners and proceed from there.

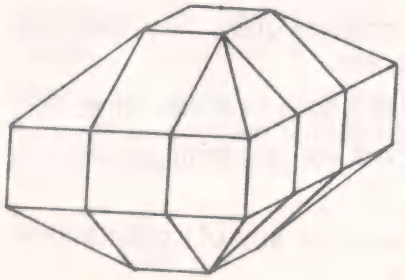
2. Middle belt edges could be correctly placed but incorrectly oriented.

You could end up with a single edge flip, or a three edge flip.

To fix this problem, take out one middle belt edge and "flip" it back to its place.

Then proceed from there.

THE FLYING SAUCER (14 FACES)



Top four edges and bottom four edges could be correctly placed but incorrectly oriented.

The most difficult one to do because of the misleading colouring on it.

PICTURE CUBES (6 FACES)

Prince Charles, fruits and vegetables, etc. Identical to regular cube, but you may encounter slight difficulty with center pieces.

SOLVING THE MYSTERIES OF THE GREAT PYRAMID™ PUZZLE

FOREWORD:

You see them by the dozen. The original cube mutilated into shapes like barrels, flying saucers, etc.

Not so the Pyramid. The Pyramid is a step in a new direction.

It is easy to illustrate the difference if you are familiar with the workings of the cube.

Put the following moves on your cube or any of its imitations:

L+R+L-R-

Those four moves had no effect.

Now put the same four moves on your pyramid:

L+R+L-R-

You see?

GETTING TO KNOW YOUR PYRAMID

Don't worry if anybody tells you your pyramid is simpler than the cube.

Simpler does not mean less interesting!!

In fact, the pyramid is far more interesting than the cube.

Whatever method you are using to restore the cube, you have to follow a well-beaten path from start to finish.

Not so with your pyramid! It allows you to pick your own strategy *every* time you are restoring it.

HOW DOES IT WORK?

WHAT YOU CAN'T SEE:

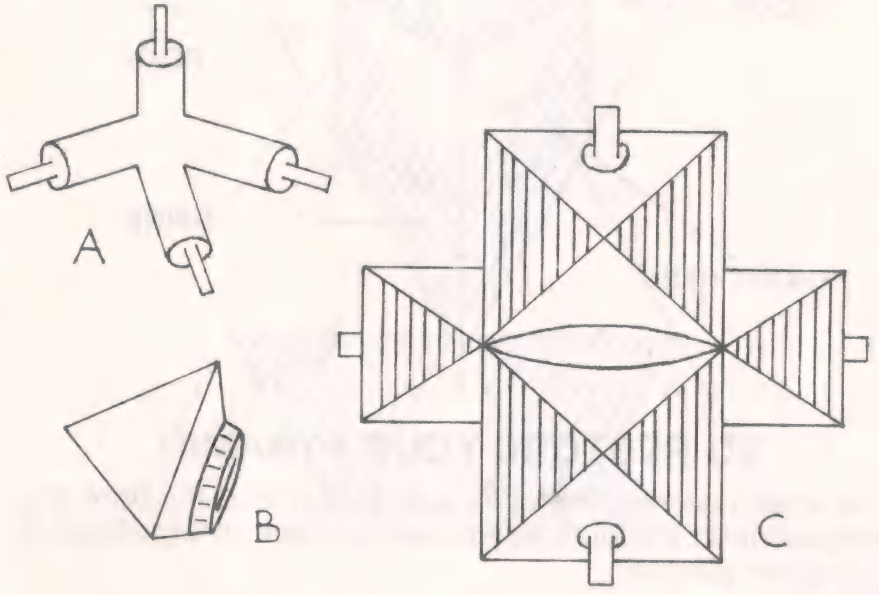
The heart of your pyramid is a four-armed, spring-loaded spider. (Illustration A)

Each roof has a crescent-shaped rim. (Illustration B)

The bases are hollowed inside and are bolted together. (Illustration C)

The roofs are free to move about and are held only by their crescent-shaped rims.

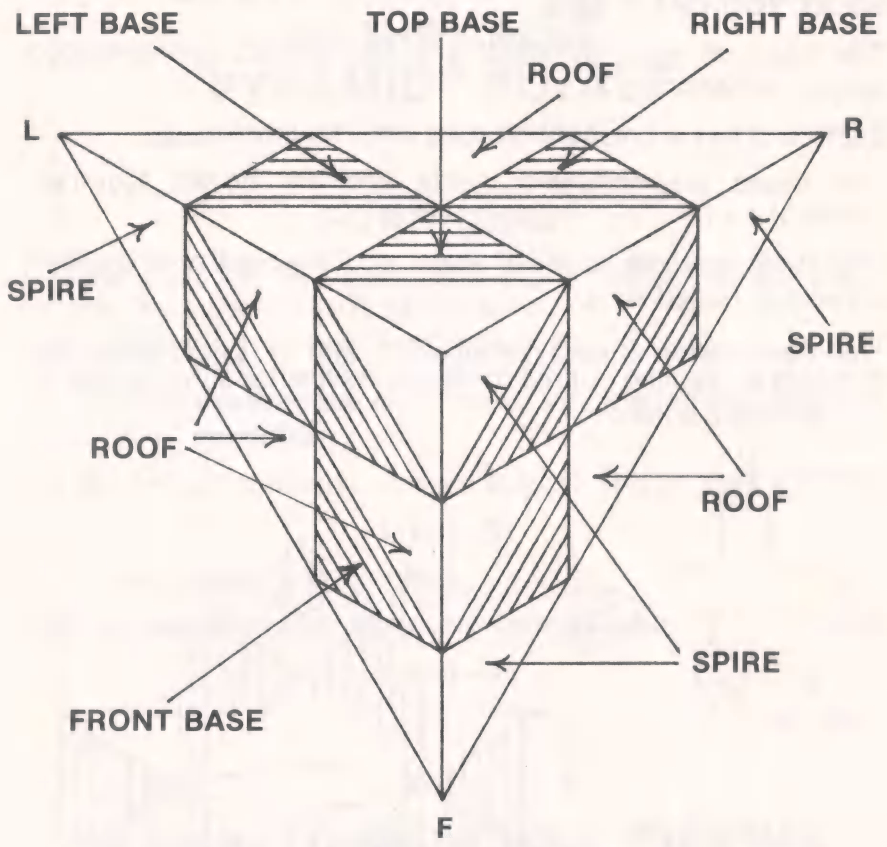
If you can open a milk carton then you can pry open your pyramid and shake out the roofs one by one for a look inside or to put vaseline inside.



WHAT YOU CAN SEE:

It has —

4 faces with 1 colour each
4 spires with 3 colours each
4 bases with 3 colours each
6 roofs with 2 colours each



TO RESTORE YOUR PYRAMID

The actual restoring Operators given further on in this book are not governed by colours, so you may use them on any coloured four-sided pyramid.

But for now, it may help to note the colours:

FRONT BASE = GOLD — BLUE — GREEN

TOP BASE = RED — GREEN — BLUE

LEFT BASE = GOLD — RED — BLUE

RIGHT BASE = GOLD — GREEN — RED

(For *other* than esthetic value, the spires have no reason to be on the pyramid. Do not break them off on purpose, but if they fall off, so much the better.)

To Start:

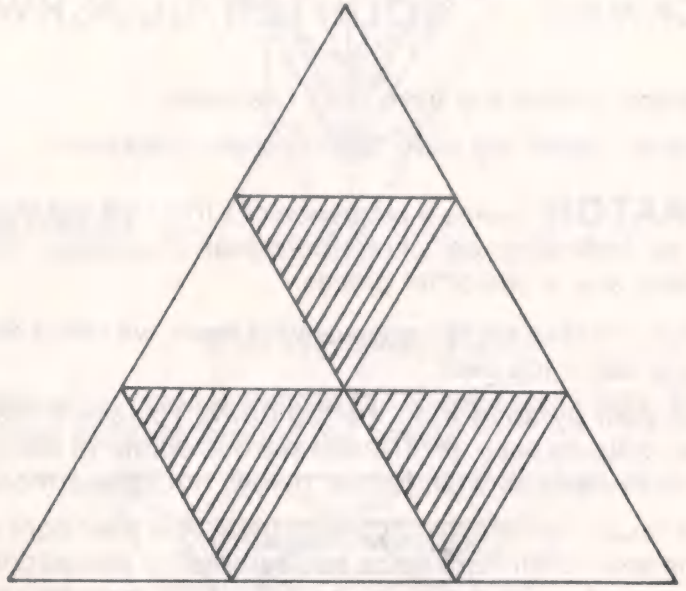
Locate the base with gold-blue-green on it. Hold it in such a way that it points towards you, with its gold face on the bottom. Now this is your front base.

Locate the base with red-green-blue on it. If it is not the top base, rotate the back face till red-green-blue is on top. Rotate top base if necessary so red is on back face. This is your top base.

Now rotate left base till its gold face is on the bottom.

Rotate right base till its gold face is on the bottom.

Now each face should have matching colours on each base.



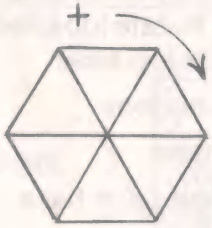
(Don't let the roofs confuse you if they happen to have the right colours.)

FIXING THE ROOF

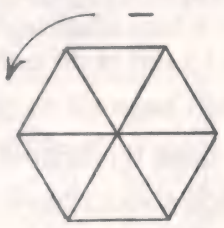
First, we learn the meaning of a few symbols:

T = TOP **L** = LEFT **R** = RIGHT

F = FRONT **B** = BACK



CLOCKWISE



COUNTER CLOCKWISE

T+ means - rotate top base 120° clockwise.

T– means - rotate top base 120° counter clockwise

OPERATOR means a sequence of turns that will move the roofs as indicated on each individual illustration without disturbing any of the other pieces.

Now that all bases are the way we want them, we could pick any base and call it top base.

Look at your pyramid from the top down: you see three roofs with two colours each. (You could see one colour of each of the other three roofs as well, further below, but ignore those.)

Are the roofs — with two colours on them — in their right place? (If some are in their right place but "twisted" — placed correctly but incorrectly oriented — don't worry about them for now. We will get to it later.)

If two or three of the roofs are in the wrong place (Placed incorrectly), try to determine if any of them would fit into its neighbour's place.

Should it move clockwise or anticlockwise?

This is where you can use your own strategy:

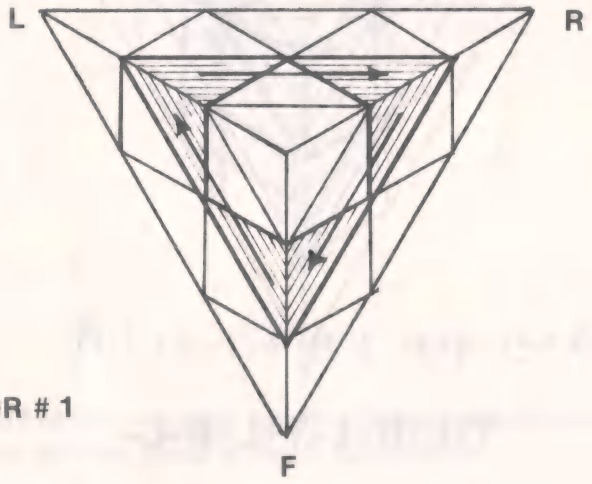
Even if the Operator you select fixes only one or two roofs, you may use it, or you may elect to use another base for top and examine the possibilities there.

It is possible to properly place all your roofs using only the following two Operators:

TO ROTATE THREE ROOFS AROUND TOP BASE

Study these pictures carefully then apply one of the Operators:

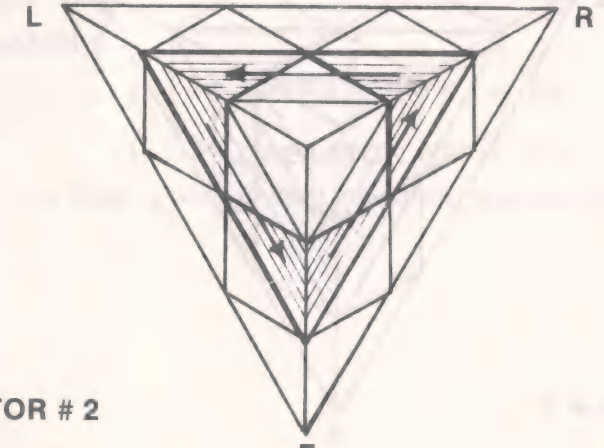
OPERATOR # 1



F+T+R+T–R–F–

The Operators given will move the shaded roofs only, the way the arrows indicate (around top base).

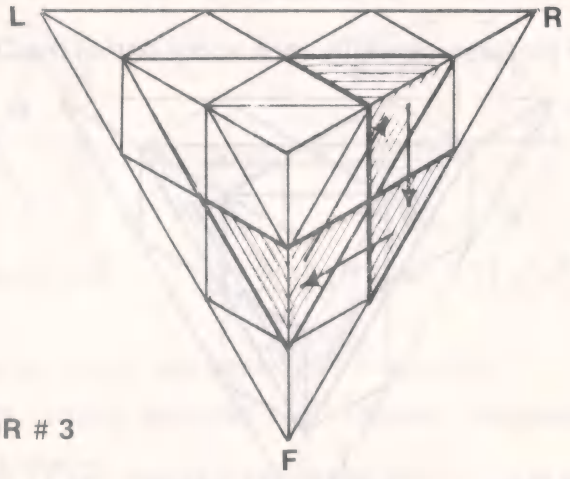
OPERATOR # 2



F+R+T+R–T–F–

MOVING THREE ROOFS ON RIGHT FACE

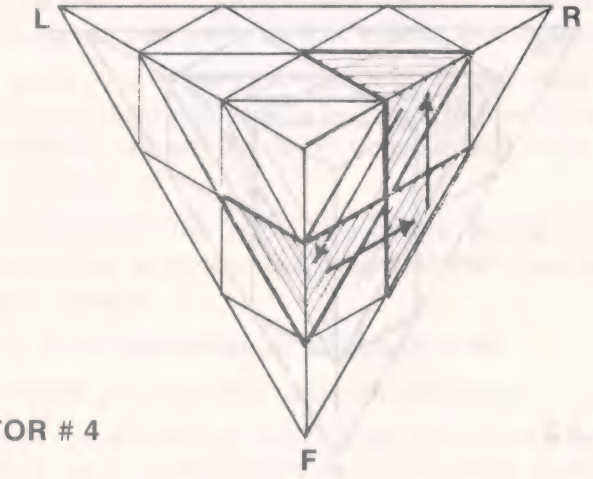
You may find it useful to use one of the following two Operators. They rotate three of the roofs on the right face.



OPERATOR # 3

T-L+R+L-T+L+R-L-

Use your own judgement again whether you want to put the moves on, or you rather examine another face.

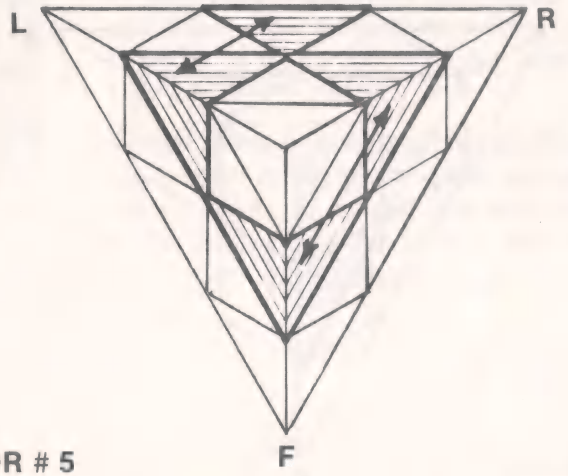


OPERATOR # 4

L+R+L-T-L+R-L-T+

EXCHANGE TWO PAIRS OF ROOFS

Here is still one more operator to help you with your strategy:



OPERATOR # 5

B+L+B-T-F-R-L-R+F+L+

As we said before, you may use this Operator to fix two or three or as many as four roofs at each application.

Interesting note:

Depending on what you have on the back face, you may find it useful to apply **L**+ or **L**- BEFORE using Operator # 5. (If you do precede your Operator with L+ or L-, be sure to reverse that one turn at the end.

FOR EXAMPLE:

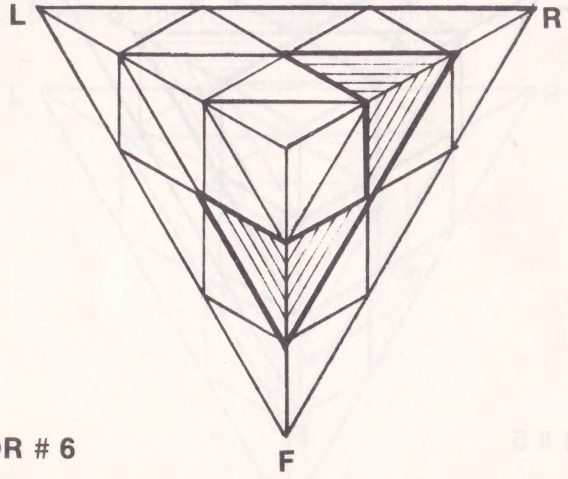
L- + OPERATOR # 5 + L+

L+ + OPERATOR # 5 + L-

(This idea is useful with the other operators too!)

FLIP TWO ROOFS

Use this operator if all your roofs are in their correct places but need twisting (correctly placed but incorrectly oriented.)



OPERATOR # 6

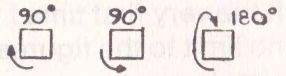
F+R+T+R-T-F-L+T+F+T-F-L-

You can wait till all your roofs are in their correct places before you twist them, or you may twist them as soon as you spot a couple of roofs to be twisted to make your pyramid less confusing.

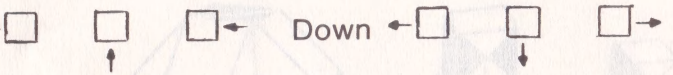
THE MISSING LINK

A very enjoyable little toy based on an old, old idea. You can have hours of pleasure playing with it. (You don't really need a formula to "solve" it.)

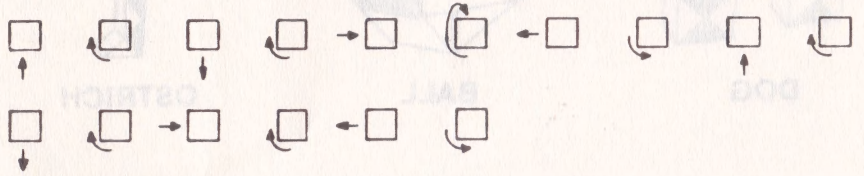
To get started, line up all the half links on one side, then bring them down to bottom row. Match them up one by one with double-half links for second and third row. If top row proves to be difficult, use the following simple:

Rotations of the top: 

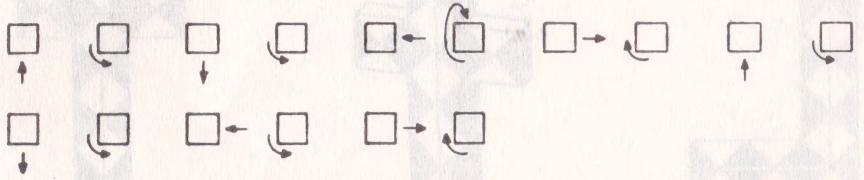
and

Slides: Up  Down

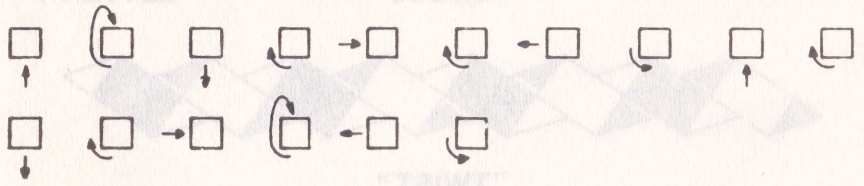
Exchange top — back — side with top — right — side:



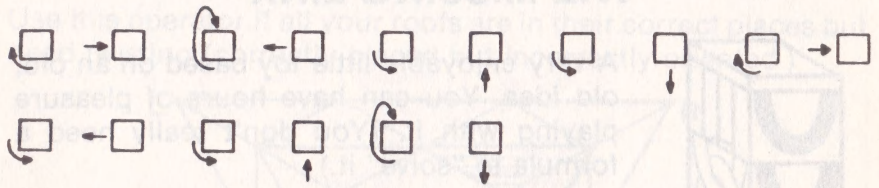
Exchange top — back — side with top — left — side:



Exchange top — three — sides clockwise:



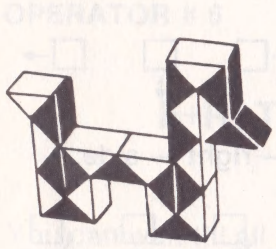
Exchange top — three — sides counter-clockwise:



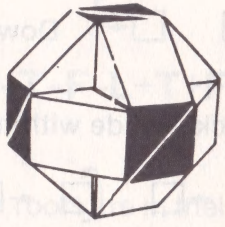
Use two of the above four lines to exchange top - left - side with top — right — side.

THE SNAKE

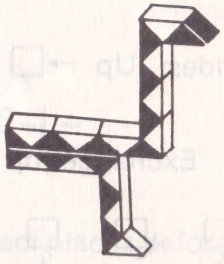
An excellent "pacifier" for young and old alike. I fell in love with it the very first time I felt its smooth shape in my hands. There is no limit to the figures you may dream up, but here are a few very simple ones.



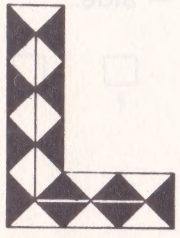
DOG



BALL



OSTRICH



LETTER L

CROSS

LETTER T

"TWIST"

Exchange top — three — sides counter-clockwise

Use two of the above four lines to exchange top — left — side with top — right — side.

THE SNAKE

An excellent "pacifier" for young and old alike. I fell in love with it the very first time I felt its smooth shape in my hands. There is no limit to the figures you may dream up, but here are a few very simple ones:

DOG BALL OSTRICH

LETTER L CROSS LETTER T

"TWIST"

UNFOLD THIS FLAP

STAGE ONE

At this stage we want to see:

A. First four edges correctly placed and correctly oriented.

B. First four corners correctly placed and correctly oriented.

STAGE TWO

At this stage we want to see top corners correctly placed. (At this stage we DO NOT worry about top edges or middle belt edges.)

STAGE THREE

At this stage we want to see top corners correctly oriented. We could be facing ONE of the following problems:

A. Two Corner Flip. (Remedy: Do Chapter Two Corner Flip PLUS Chapter Four Corner Flip PLUS Chapter Three Corner Clockwise Flip - 21 turns.)

B. Four Corner Flip. (Remedy: Do Chapter Four Corner Flip PLUS Chapter Three Corner Clockwise Flip - 14 turns.)

C. Three Corner Anticlockwise Flip. (Remedy: Do Chapter Three Corner Anticlockwise Flip PLUS chapter Clockwise Flip - 14 turns.)

D. Three Corner Clockwise Flip. (Remedy: Do Chapter Three Corner Clockwise Flip - 7 turns.)

(At this stage we do not worry about top edges or middle belt edges.)

STAGE FOUR

At this stage we want to see:

A. Top edges correctly placed.

B. Middle belt edges correctly placed.

STAGE FIVE

At this stage we do whatever flips need to be done.

FOR YOUR CONVENIENCE

OP. # 1 $U-^{1}LUL-^{1}U-^{1}B-^{1}U-^{1}B$

OP. # 2 $FUF-^{1}UFU^{2}F-^{1}$

OP. # 3 $LR-^{1}U^{2}L-^{1}RB^{2}$

OP. # 4 $LR-^{1}FLR-^{1}DLR-^{1}B^{2}L-^{1}R$ $DL-^{1}RFL-^{1}RU^{2}$